

**EARTH OBSERVING SYSTEM
GEOSCIENCE LASER ALTIMETER SYSTEM**

**GLAS Level 0 Instrument Data
Product Specification**

Updated Preliminary

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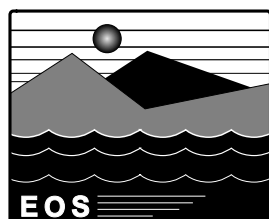


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Preface

The GEOSCIENCE LASER ALTIMETER SYSTEM (GLAS) is a part of the EOS program. This laser altimetry mission will be carried on the spacecraft designated EOS LASER ALT. The GLAS laser is a frequency-doubled, cavity-pumped, solid state Nd:YAG laser.

This document addresses the data flow, interfaces, record and data formats associated with the GLAS Level 0 instrument data products. The term “instrument data products” refers to those EOS instrument/payload data products listed in the Earth Science Data and Information System (ESDIS) Project data base that are routinely generated within the EOS Data and Operations Systems (EDOS) and archived in the Distributed Active Archive Center (DAAC).

Level 0 instrument data products are composed of time ordered raw instrument packet data recorded at the original resolution with any redundant or duplicate data packets removed.

Section 1

Introduction

1.1 Identification of Document

This document is identified as the GLAS Level 0 Instrument Data Product Specification. The unique document identification number within the GLAS Ground Data System numbering scheme is GLAS-DPS-2610. Progressive editions of this document will be uniquely identified by the cover and page date marks.

1.2 Scope of Document

This document addresses the purpose, usage, and description of the GLAS Level 0 Instrument Data Product. The intended audience for this document is the GLAS Science and Instrument Engineering Teams, the ESDIS Project, the community of EOS data users and investigators, and the GLAS Ground Data System Team.

1.3 Purpose and Objectives of Document

The purpose of the GLAS Level 0 Instrument Data Product Specification is to provide a detailed descriptive document for the spacecraft and instrument data product. This document describes the purpose, usage, content, and format of the GLAS Level 0 Data Product. It describes the representation and definition of the GLAS data elements constituting the GLAS data parameters. It further describes the structure, physical storage, organization, and access characteristics of the GLAS Level 0 Data Product. The document additionally describes file transfer methods to support product access, the data flow associated with the data product, and the data storage and generation characteristics of the data product.

1.4 Document Status and Schedule

This document is currently being released as an updated preliminary. The schedule defined in Table 1-1 "Document Delivery Schedule" lists the planned editions and updates for this document.

Table 1-1 Document Delivery Schedule

Edition/Revision Designation	Document Edition Description	Edition Delivery Focus	Activity/ Delivery Dates
UPDATED PRE-LIMINARY	revised document edition delivered to EOSDIS by GLAS Science Team Leader	EOSDIS, EOS	December 1997

1.5 Document Organization

This document's outline is assembled in a form similar to those presented in the NASA Software Engineering Program [Information Document 2.3a].

Related Documentation

2.1 Parent Documents

The GLAS Level 0 Instrument Data Product Specification document represents a data description that is considered a “roll-out” from the Product Specification as the parent document or volume. Specific topics pertaining to data descriptions are located in the External Interface section under the Detailed Design document template, NASA-DID-P400.

This document is subordinate to any top-level mission or instrument documents, and as such, recognizes these documents as external parent documents in lineage. The recognized external EOSDIS and GLAS parent documents superior to the GLAS Level 0 Instrument Data Product Specification are listed below.

- *EOS ALT/GLAS Mission Requirements Document*, Version 1.5, Center for Space Research, University of Texas at Austin, July 1993.
- *GLAS Science Software Development Management Plan*, Preliminary, NASA Goddard Space Flight Center, Wallops Flight Facility, December 31, 1995.

2.2 Applicable Documents

The following documents are applicable to, or contain policies or references pertinent to the contents of the GLAS Level 0 Instrument Data Product Specification.

- a) *EOS Altimetry/GLAS Phase-A Study*, NASA Goddard Space Flight Center, November 1995.

2.3 Information Documents

The following documents are provided as sources of information that provide background or supplemental information that may clarify or amplify material in the GLAS Level 0 Instrument Data Product Specification.

- a) *NASA Software Documentation Standard Software Engineering Program*, NASA, NASA-STD-21000-91, July 29, 1991.
- b) *The Geoscience Laser Altimetry/Ranging System*, IEEE Transactions on Geoscience and Remote Sensing, Vol. GE-25, No. 5, September 1987.
- c) *Memorandum: GLAS Data Products*, Center for Space Research, University of Texas at Austin, December 23, 1993.
- d) *Data Production Software, Data Management, and Flight Operations Working Agreement for AIRS, AMSU-A and MHS/AMSU-B*, NASA Goddard Space Flight Center, January 1994.

Purpose and Description of the Data Product

3.1 Purpose of the Data Product

The purpose of the GLAS Level 0 Instrument Data Product is to provide the initial collection of GLAS instrument data. Appendix A contains the description of the packet organization and frequency of the GLAS instrument data from the spacecraft. The EOS Data and Operations System (EDOS) receives the GLAS Level 0 packets and transfers the packets to the EOSDIS Distributed Active Archive Center (DAAC) data storage facility for subsequent archival. At the DAAC, the Level 0 Instrument Data Product is produced and is used as input to the GLAS Level 1A and Level 1B data product generation processing.

The altimeter, the LIDAR, and the housekeeping data packets provide the source data for the generation of the GLAS Level 1A data products. The GLAS Science Team will use the attitude and positional data parameters from the Stellar Reference System and GPS data packets for the precision orbit and precision attitude generation within the GLAS Science Computing Facility.

The Level 0 data packets are available through EDOS for GLAS Operations Team instrument performance monitoring and for product quality monitoring (i.e., quality assurance) on the GLAS Instrument Support Terminal. The GLAS Level 0 Data Product is available to the DAAC Operations Team for Level 1A and Level 1B Data Products generation, to the GLAS Science Team, and to the EOS data user community for retrieval and analysis purposes from the DAAC.

Figure 3-1 "EOS ALT Spacecraft and GLAS Instrument Data Flow Diagram" depicts the data flow of the GLAS instrument.

3.2 Description of the Data Product

The GLAS Level 0 Instrument Data Product contains data generated by the GLAS instrument and the EOS LASER ALT spacecraft. Appendix A contains the GLAS Instrument Team's overview of the expected data from the GLAS instrument and spacecraft subsystems and their rates. The instrument team groups the data in packets; these packets equate with EOSDIS parameters. The raw instrument data from the GLAS LASER Altimeter and LIDAR subsystems are collected and stored as the altimeter and LIDAR data packets. Engineering data including temperature, voltage, current monitors, and status values are contained in the housekeeping data packet. The instrument attitude and position reference data from the stellar reference system (SRS) and the GPS receiver subsystem are collected to compose the SRS and GPS packets. Table 3-1 "GLAS Level 0 Standard Data Products" identifies the Level 0 Data Product as the GLAS Instrument Packet.

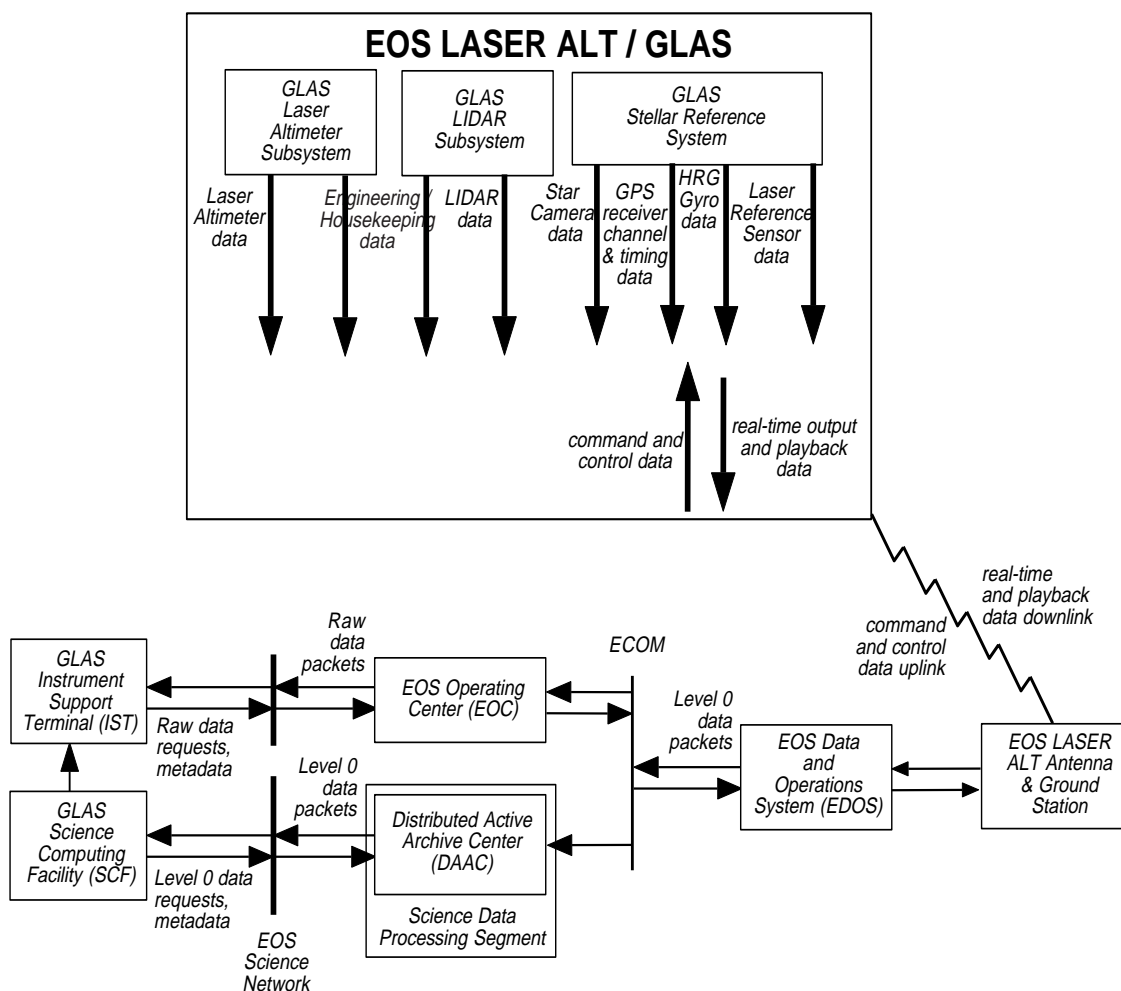


Figure 3-1 EOS ALT Spacecraft and GLAS Instrument Data Flow Diagram

Table 3-1 GLAS Level 0 Standard Data Products

Product ID (Identification)	Product Name	Product Level	Number of Parameters
GLA00	GLAS Instrument Packet	0	7

While the text within this document refers to the product as the GLAS Level 0 Data Product, the actual name of the product is the GLAS Instrument Packet. The Level 0 Data Product consists of seven packet types that are specifically identified as the Level 0 Data Parameters and enumerated in Table 3-2 "GLAS Level 0 Standard Data Parameters".

Each Level 0 Data Parameter is decomposable into one or more GLAS Data Elements (see Table 3-2). A GLAS Data Element is decomposable into either an Item(s) or an Array of Items as indicated in Table 3-3 "GLAS Level 0 Standard Data Elements".

Table 3-2 GLAS Level 0 Standard Data Parameters

Product ID	Parameter Number	Parameter Name	Number of Elements
GLA00	GLL01	Altimetry Data	11
GLA00	GLL02	Lidar Data	15
GLA00	GLL03	Star Camera Centroid Packet	3
GLA00	GLL04	Laser Reference System Packet	17
GLA00	GLL05	GPS Data Packet	4
GLA00	GLL06	HRG Gyro Packet	3
GLA00	GLL07	Housekeeping Packet	27

Table 3-3 GLAS Level 0 Standard Data Elements

Parameter Number	Element Name	Elem/Sec	Bytes/Item	Items/Elem	Bytes/Sec
GLL01	1064 nm Background Signal	40.00	1.00	1	40.00
GLL01	1064 nm Laser Transmit Energy	40.00	1.00	1	40.00
GLL01	A/D Samples	40.00	1.00	400	16000.00
GLL01	Altimetry Packet Header	1.00	1.00	8	8.00
GLL01	Delta-TIU Address Data	40.00	2.50	1	100.00
GLL01	Detector Status (A or B)	1.00	1.00	1	1.00
GLL01	Filter and Tracking Parameters and Status	40.00	1.00	10	400.00
GLL01	Laser Shot GPS Timing Vernier	1.00	2.50	1	2.50
GLL01	Programmable Gain Amplifier Setting	1.00	1.00	1	1.00
GLL01	Spacecraft Time Code	1.00	4.00	1	4.00
GLL01	Waveform Averaging Multiplier	40.00	0.50	1	20.00
GLL02	1064 nm Background Data from -5 KM to -4.25 KM	40.00	1.00	16	640.00
GLL02	1064 nm Lidar Data from 10 KM to -1 KM	40.00	1.00	146	5840.00
GLL02	1064 nm Lidar Data from 20 KM to 10 KM	5.00	1.00	133	665.00
GLL02	532 nm Background Count Integration Intervals	40.00	2.00	2	160.00
GLL02	532 nm Laser Transmit Energy	4.00	1.00	1	4.00
GLL02	532 nm Laser Transmit Energy Threshold	5.00	1.00	1	5.00
GLL02	532 nm Lidar Data from 10 KM to -1 KM	40.00	1.00	146	5840.00

Table 3-3 GLAS Level 0 Standard Data Elements (Continued)

Parameter Number	Element Name	Elem/Sec	Bytes/Item	Items/Elem	Bytes/Sec
GLL02	532 nm Lidar Data from 20 KM to 10 KM	5.00	1.00	133	665.00
GLL02	532 nm Lidar Data from 40 KM to 20 KM	1.00	1.00	267	267.00
GLL02	Flags	5.00	1.00	1	5.00
GLL02	LIDAR Threshold D/A Setting	2.00	1.00	1	2.00
GLL02	Lidar Packet Header	1.00	1.00	8	8.00
GLL02	Range Delay for Start of 1064 nm Lidar Data 20 KM Segment	1.00	2.00	1	2.00
GLL02	Range Delay for Start of 532 nm Lidar Data 40 KM Segment	5.00	2.00	1	10.00
GLL02	Spacecraft Time Code	1.00	4.00	1	4.00
GLL03	Spacecraft Time Code	1.00	4.00	1	4.00
GLL03	Star Camera	4.00	2.00	182	1456.00
GLL03	Star Camera Data Header	1.00	1.00	8	8.00
GLL04	CCD Sector Gyro Pointing Image	1.00	1.50	100	150.00
GLL04	CCD Sector Laser Pointing Image	40.00	1.50	256	15360.00
GLL04	CCD Sector Star Camera Pointing Image	1.00	1.50	100	150.00
GLL04	CCD Sector Star Image	40.00	1.50	100	6000.00
GLL04	GPS Broadcast UTC Offset	1.00	4.00	1	4.00
GLL04	Gyro Centroid	40.00	2.00	3	240.00
GLL04	Gyro Sector Address	1.00	1.13	2	2.25
GLL04	LRS Data Header	1.00	1.00	8	8.00
GLL04	Laser Centroid	40.00	2.00	3	240.00
GLL04	Laser Sector Address	40.00	1.13	2	90.00
GLL04	Laser Shot Counter	40.00	1.00	1	40.00
GLL04	Laser Shot GPS Timing Vernier	1.00	4.00	1	4.00
GLL04	Spacecraft Time Code	1.00	4.00	1	4.00
GLL04	Star Camera Centroid	40.00	2.00	3	240.00
GLL04	Star Camera Sector Address	1.00	1.13	2	2.25
GLL04	Star Centroid	40.00	2.00	3	240.00
GLL04	Star Sector Address	40.00	1.13	2	90.00

Table 3-3 GLAS Level 0 Standard Data Elements (Continued)

Parameter Number	Element Name	Elem/Sec	Bytes/Item	Items/Elem	Bytes/Sec
GLL05	GPS Data	1.00	1.00	500	500.00
GLL05	GPS Data Header	1.00	1.00	8	8.00
GLL05	GPS Ephemeris and Velocity Message	0.10	4.00	7	2.80
GLL05	Spacecraft Time Code	1.00	4.00	1	4.00
GLL06	HRG Gyro (Litton)	40.00	3.00	12	1440.00
GLL06	Header	1.00	1.00	8	8.00
GLL06	Spacecraft Time Code	1.00	4.00	1	4.00
GLL07	Electronic Monitors	10.00	1.50	13	195.00
GLL07	Electronic Pulse Trigger Timing	10.00	1.50	1	15.00
GLL07	Electronic Pump	10.00	1.50	2	30.00
GLL07	Etalon Filter Feedback Monitor	1.00	2.00	1	2.00
GLL07	Etalon Filter Heater Drive Control Point	1.00	2.00	1	2.00
GLL07	Etalon Filter Temperature	1.00	2.00	1	2.00
GLL07	Feedback Monitor Value (Quad Det)	1.00	2.00	4	8.00
GLL07	GPS Broadcast Lat and Lon	1.00	4.00	2	8.00
GLL07	GPS Broadcast UTC Offset	1.00	4.00	1	4.00
GLL07	HOP Mechanism Drive Value	1.00	1.00	15	15.00
GLL07	HOP Mechanism Limit	1.00	1.00	15	15.00
GLL07	HOP Mechanisms Monitor	1.00	1.00	15	15.00
GLL07	Housekeeping Data Header	1.00	1.00	8	8.00
GLL07	Laser A,B,C Select Status	1.00	1.00	3	3.00
GLL07	Laser Shot Counter	40.00	1.00	1	40.00
GLL07	Limit Position status	1.00	0.25	2	0.50
GLL07	Miscellaneous Housekeeping	1.00	2.00	25	50.00
GLL07	Motor Encoder Position (2 axis)	1.00	2.00	2	4.00
GLL07	Motor Input Control Command	1.00	2.00	2	4.00
GLL07	Power Converter Voltage	1.00	1.00	20	20.00
GLL07	Power Converters Current	1.00	1.00	20	20.00
GLL07	Power Converters Temperatures	1.00	1.00	20	20.00

Table 3-3 GLAS Level 0 Standard Data Elements (Continued)

Parameter Number	Element Name	Elem/Sec	Bytes/Item	Items/Elem	Bytes/Sec
GLL07	Spacecraft Time Code	1.00	4.00	1	4.00
GLL07	System Status	1.00	2.00	50	100.00
GLL07	Temperature Controller Drive Value	1.00	1.00	15	15.00
GLL07	Temperature Controller Set Points	1.00	1.00	15	15.00
GLL07	Thermal Temperatures	1.00	1.00	15	15.00

The specific details of the table assume an aggregation or assembly span of one-second. [Depending on the specific parameter, the parameter is assembled at the rate of either one, four, or ten packets per second.] This table is ordered by the GLAS Level 0 Parameter Number and provides the Element Name, the number of Elements per Second, the size in number of Bytes per Item, the number of Items per Element, and the Total Bytes required for the element within the one-second packet aggregation. The Total Bytes in the GLAS Data Element for the aggregation period are obtained by the multiplication of the Elements per Second times the Bytes per Item times the Items per Element. Figure 3-2 "GLAS Level 0 Data Product Composition and Terminology Pyramid" depicts the composition and the terminology used to represent the data product and its decomposition.

The Level 0 Data Parameters are measurements and associated monitor values obtained from specific GLAS instrument or spacecraft subsystems. In addition to the Level 0 Data Parameters, the Data Product will have associated standard EOS Packet Data Labels containing identification, processing history, and data content descriptive information.

The input data flow begins with the collection of the GLAS Laser Altimeter, LIDAR, housekeeping (including engineering monitors, GPS timing, and other), GPS receiver, twin star camera, and external laser pointing monitor data in the GLAS flight computer. Concurrently, the EOS LASER ALT spacecraft computer is collecting the GLAS flight computer data and the spacecraft monitor data for recording and downlink.

The data streams are recorded for subsequent downlink real-time or stored for data playback. The EDOS Ground Data System software performs any processing required on the downlink (from the spacecraft) data so that it looks like the output from the GLAS instrument, i.e., uncompresses the data or remove any headers placed on the data by the spacecraft prior to transmission. The output data from the EDOS is delivered to the DAAC and eventually archived in the DAAC.

Figure 3-3 "GLAS Level 0 Data Product Within the Processing Hierarchy" illustrates the source GLAS instrument and spacecraft subsystem data being collected on the EDOS and transferred to the DAAC for data product generation and archival. In sup-

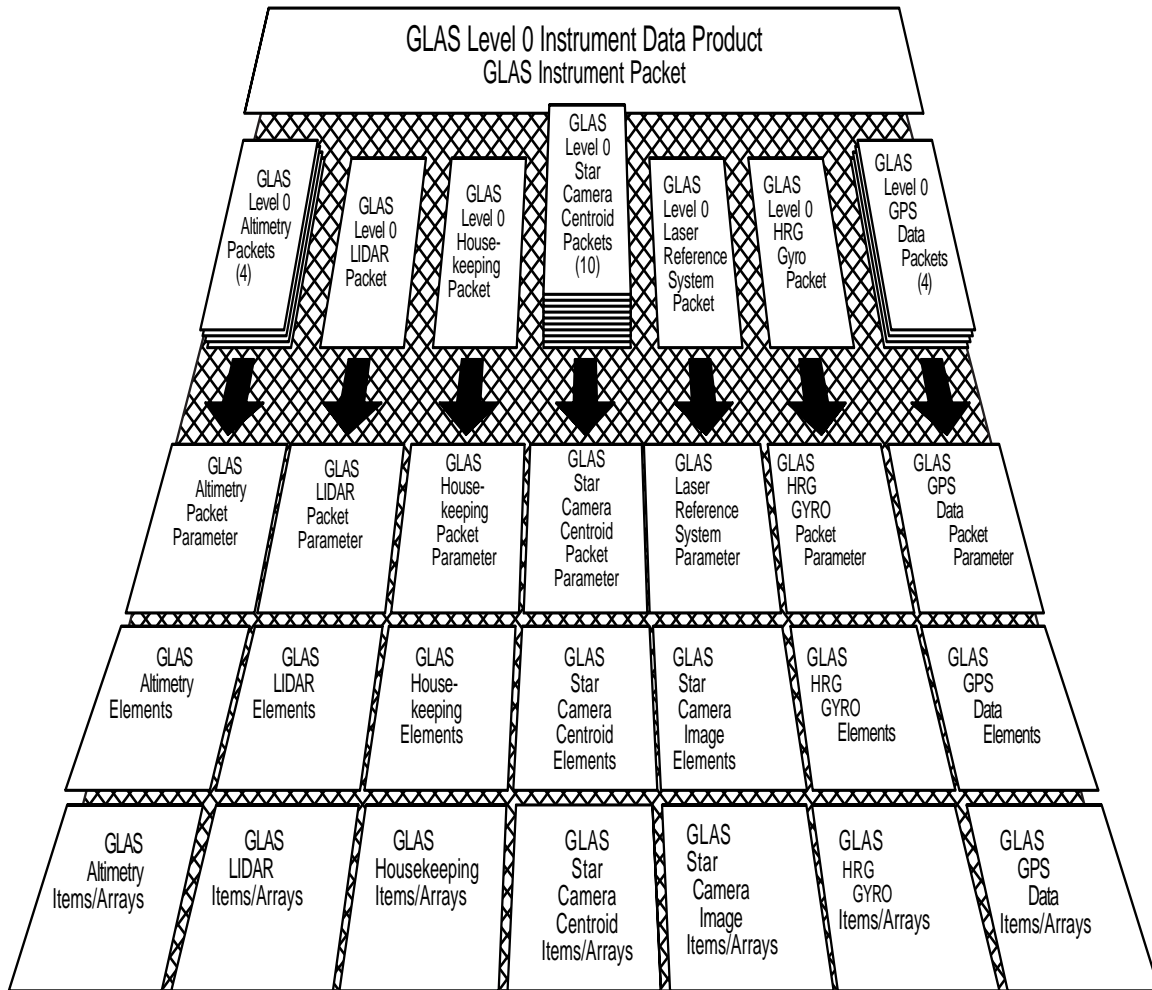


Figure 3-2 GLAS Level 0 Data Product Composition and Terminology Pyramid

port of the GLAS Science Team, the GLAS Operations Team performs instrument performance assessment and assurance monitoring at the GLAS Instrument Support Terminal (IST); this processing returns instrument performance and quality data, and descriptive metadata to EOSDIS for incorporation in the EOS data base system.

The specific details of the data product structure, content, format, and data element details are addressed in Section 6. Data sizing, storage burden, and physical media details are provided in Section 5.

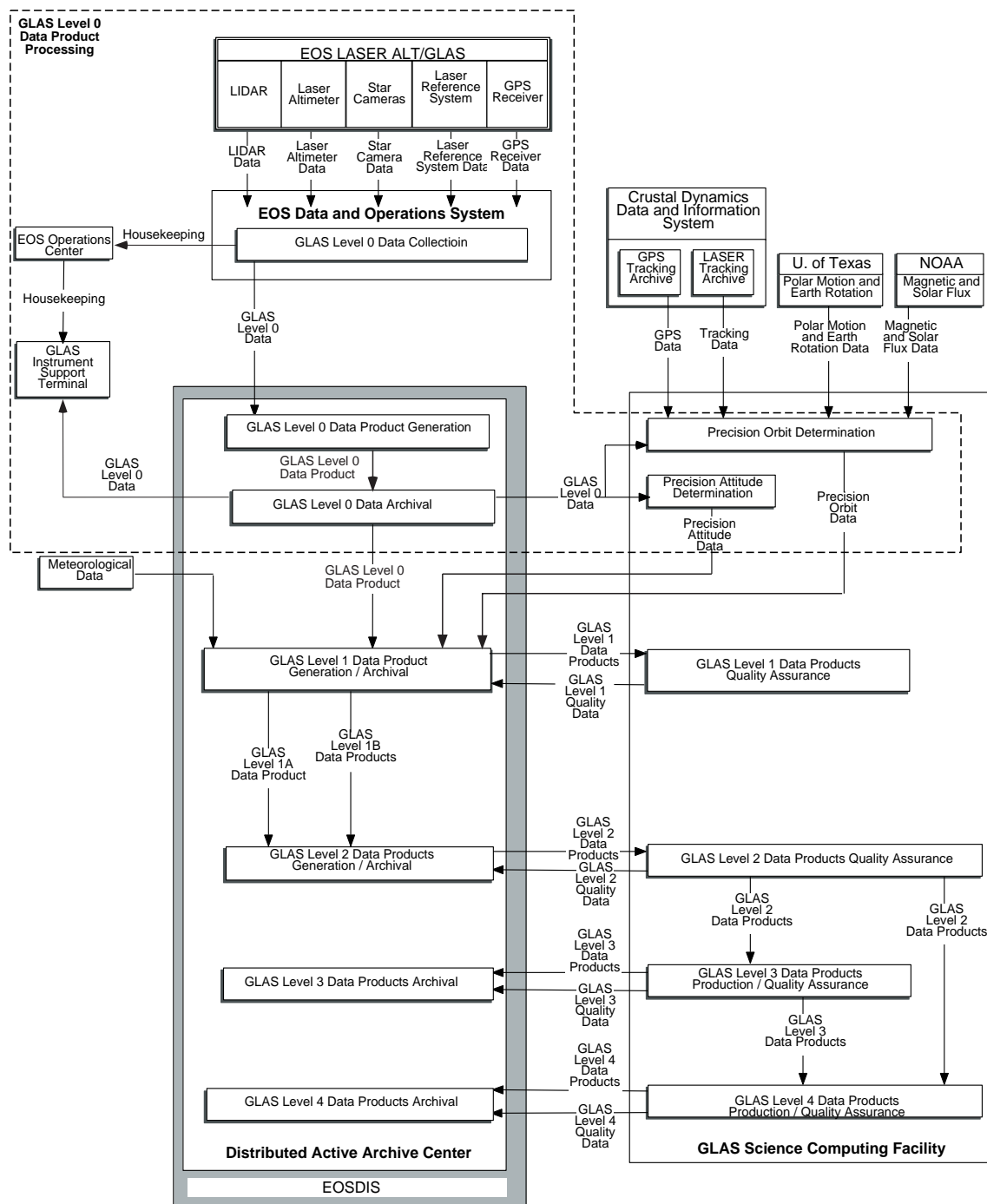


Figure 3-3 GLAS Level 0 Data Product Within the Processing Hierarchy

Section 4

Environment

4.1 Hardware Characteristics and Limitations

The GLAS raw telemetry data are generated by the Laser Altimeter, LIDAR, and instrument engineering housekeeping subsystems during in-flight operation of the GLAS instrument. Additionally, the spacecraft broadcast time (from the GPS receiver) is accessed to provide coarse time tags for the GLAS data taking activity. The GLAS data collection is performed by the instrument flight computer subsystem, interfaced to the spacecraft through the data bus.

The attitude and position reference data are gathered during flight operations from the dual Star Cameras, the 12-channel GPS receiver, and the quad cell external laser pointing monitor. These spacecraft subsystems are interfaced to the instrument flight computer system through the data bus. These spacecraft subsystems packets are delivered from the instrument flight computer system to the EOS LASER ALT flight computer system through the spacecraft data bus interface.

The GLAS instrument flight computer system will supply adequate buffering and on-board flight recorder capability to capture, record, and packetize the GLAS and attitude and position data during flight operations. The EOS ALT flight computer system will supply adequate buffering and on-board flight recorder capability to capture and record the GLAS and attitude and position data packets during flight operations. Sufficient excess data capacity is essential to provide the ability to retain all instrument and spacecraft data between ground station link events.

After EDOS accesses the GLAS raw telemetry data, ground processing is performed by EDOS to decode and assess the telemetry data stream, and to make the spacecraft data available for access. The data are available to the GLAS Instrument and Science Teams from the EOS Operating Center (EOC) and the DAAC.

The Level 0 data is initially accessed for instrument performance assessment through the GLAS Instrument Support Terminal (IST) from the EOS Operating Center. Subsequent Level 0 Data Product access from the DAAC for quality assurance (QA) monitoring is performed through the GLAS Science Computing Facilities (SCFs). The GLAS IST and SCFs consist of EOSDIS compatible UNIX systems that interface to the EOSDIS Network, and support the GLAS Instrument and Science Team operations including the instrument performance and data quality monitoring.

Figure 4-1 "GLAS Level 0 Data Product Flow Within the DAAC and SCF Architecture" provides a block diagram of the relationship of the GLAS Level 0 Instrument Data Product to the EDOS facility, the DAAC facility for GLAS product generation, and to the GLAS Science Computing Facility.

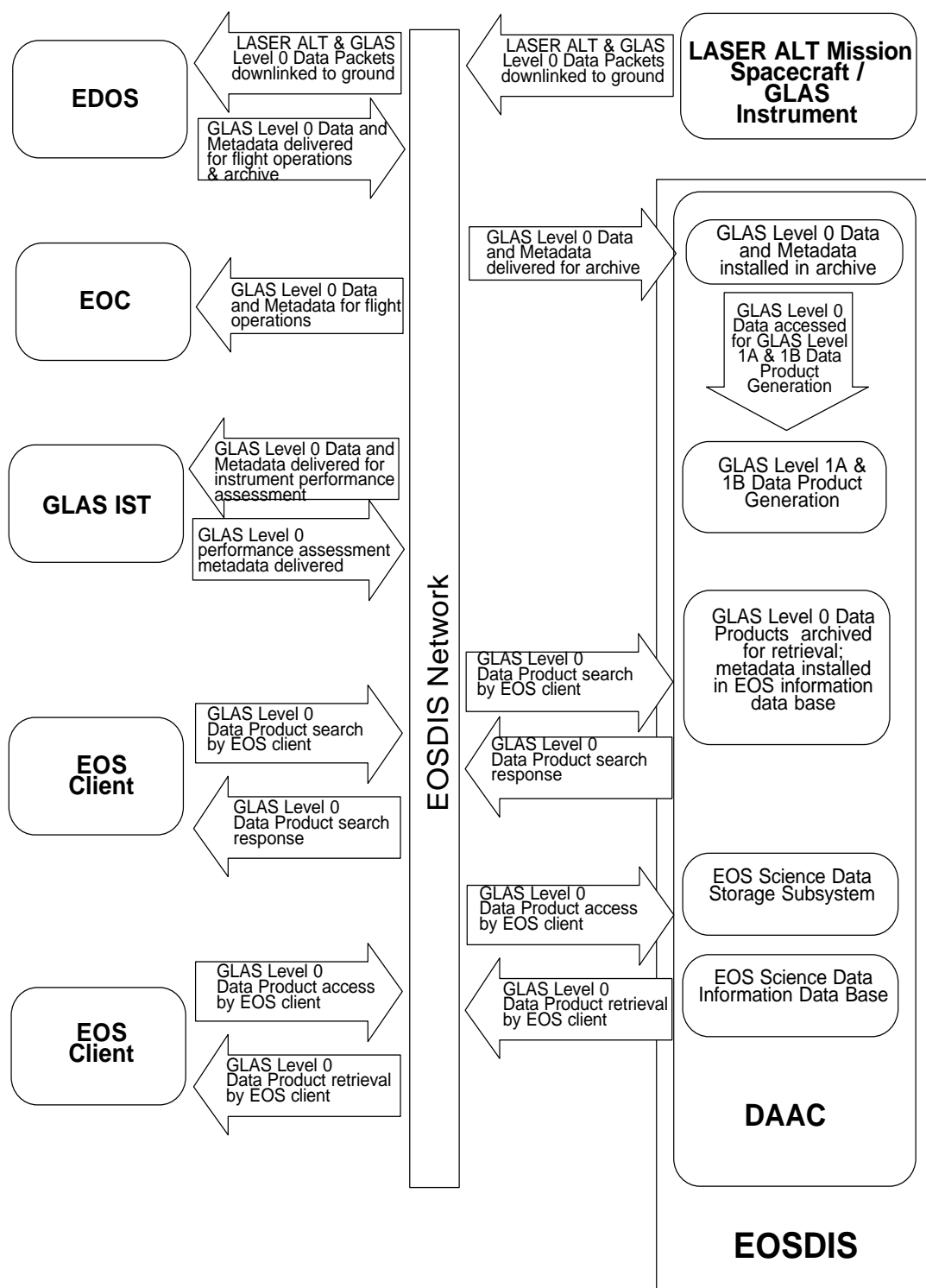


Figure 4-1 GLAS Level 0 Data Product Flow Within the DAAC and SCF Architecture

4.2 Data Product Medium and Characteristics

The data product will be archived within the DAAC. The storage system will contain not only the Level 0 Data Product, but will also contain data descriptions and data advertisements (i.e., textual descriptive and abstract information, also called meta-data). The Level 0 Data Product will be part of the Earth Sciences data collection while the information describing and documenting the data product will be a part of the supporting data base collection.

The Earth Science data are implemented in the current EOSDIS system through a hierarchical storage manager interface. Physical media supported by the storage system interface will include the disk storage subsystems, magnetic or optical media subsystems, and tiered archive robotics storage subsystems. The DAAC hierarchical storage arrangement consists of two functional subsystems: 1) the data repository subsystem, and 2) the working storage subsystem.

The GLAS Level 0 Data Product will transition between DAAC working storage and data repository media. EOS client data distribution access is accommodated through the DAAC distribution management function. This DAAC function supports client access of the GLAS Level 0 Data Product with disk storage, distribution peripherals, and a network access arrangement. Clients can directly access the GLAS Level 0 data from the storage system and can copy the data product to their host processors across the EOSDIS Network. Data requests can also be fulfilled through the preparation of magneto-optical or magnetic media.

4.3 Protocol and Conventions

At the core of the DAAC architecture will be the file structures, operating system protocols, input/output protocols, device addressing, and data representation inherent in the standard UNIX environment. These UNIX protocols and conventions will be removed from direct access by DAAC staff and client users through the subsystem applications, COTS packages, data managers, and data handlers installed on the DAAC subsystem components. The visible conventions and protocols then become those of the IST, SCF, and other EOS-supplied libraries (toolkits) provided to support the external data introduction, data storage and archival, data product generation, and EOS data client access through the various subsystems of the DAAC architecture.

EOS and EOSDIS specific protocols and conventions will be documented by the Project. Specific topics for these documents are expected to be traceability notation, metadata, keyword/value conventions, file and record structure, EOF notation, markers, and label structure and content. Device addressing and input/output protocols will be presented in the Project documentation describing the specification and use of the EOSDIS supplied libraries (toolkits).

Data definition terminology specific to the GLAS Level 0 Data Product is presented in the Glossary at the end of this document.

4.4 Failure Protection, Detection, and Recovery Features

GLAS Level 0 Data Product failure protection, detection, and recovery will be functions of the DAAC Operations Team. The generated GLAS Level 0 Data Product will be “backed up” under the routine operational functions performed by the EDOS and DAAC processing subsystems. In the event of failure or error detection in the active working or archive storage containing GLAS Level 0 data at EDOS or the specific DAAC site, recovery would be performed from backup media. The security and integrity of the GLAS Level 0 Data Product will be protected by the working storage and archive schema of the EDOS and DAAC data storage subsystems, and through the access and data management protocols established by the various EOSDIS and client data handling tools.

Initial GLAS Level 0 data error detection including monitoring for packet loss and corruption is performed at the EDOS as part of the packet collection process. EDOS will report this information as part of the Level 0 metadata. Instrument performance assessment will be performed at the IST using the Level 0 data retrieved from either the EDOS Level 0 housekeeping data or from the Level 0 Data Product stored on the DAAC. Additional instrument performance assessment and product quality assurance of the Level 0 data will be performed on the DAAC as part of the Level 1A processing. Should the need arise, GLAS ground data system support personnel will be available to assist DAAC data specialists and product support personnel in determining the nature of an internal GLAS Level 0 Data Product problem.

Data Flow Characteristics

5.1 Volume, Size, and Frequency Estimates

The expected daily data storage burden for the GLAS Level 0 Instrument Data Product is listed in Table 5-1 “GLAS Level 0 Data Product Daily Storage Burden”. This estimate is based on the following EOS LASER ALT operational assumptions. The spacecraft will orbit the Earth at an inclination of 94 degrees and a nominal altitude of 705 kilometers in a circular orbit. The orbit (ground track) repeat cycle is one-half year based on a frozen orbit. The EOS LASER ALT orbit period will be approximately 100 minutes, with a pass period duration of approximately 50 minutes (the product file collection period). The GLAS instrument and the EOS LASER ALT spacecraft are expected to operate continuously over a five-year period.

Table 5-1 GLAS Level 0 Data Product Daily Storage Burden

Product ID	Volume (MBytes per Day)
GLA00	4982.02

5.2 Data Transfer and Transmission

The majority of data transfers within the EOSDIS architecture involving the GLAS Level 0 Instrument Data Product will utilize the internal part of the EOS Science Network. The current Ethernet network access arrangement is based on the TCP/IP (or other) protocols and is performed using UNIX command operations, or will use tools implemented under the DAAC. The GLAS Level 0 Data Product generated within the EDOS operations subsystems and delivered to the DAAC processing subsystem will be designated by the DAAC Operations Team for fail-safe functions, for GLAS Instrument Team performance assessment, and for the GLAS Science Team product assurance support. GLAS Level 0 Data Product approved for archive installation and client access, and associated descriptive metadata for data base installation, are also delivered using the EOS Network.

Data access by EOS clientele for the purpose of retrieving the GLAS Level 0 Instrument Data Product primarily uses the EOS Science Network. EOS clients will electronically retrieve the GLAS Level 0 data using UNIX network support commands or specialized tools supplying the data retrieval capability through the DAAC Client support subsystem. Alternately, the client may request media preparation for off-line delivery rather than the electronically transferred data.

5.3 Timing and Sequencing Characteristics

The GLAS Level 0 Instrument Data Product is generated as a collection of data packets. The basic aggregation of the GLAS Level 0 Data Product is the Instrument and Spacecraft Data Parameters and GLAS Data Elements in the data packets. Each packet type consists of one-second of collected GLAS science instrument data (LASER altimeter and LIDAR), GLAS instrument engineering / housekeeping data, GPS receiver data, star camera data, and external laser pointing monitor data. The data parameters and elements contained within the packet are groups of forty hertz, five hertz, two hertz, and one hertz rate data. Depending on the frequency of the particular subsystem, the packets are collected at the rate of either ten, four, or one packet per second. The one-second collection of data packets will be identified by packet time tags referenced to the GPS receiver (spacecraft broadcast) time, augmented by the GLAS high resolution timing vernier, and recorded in the housekeeping packet type.

All one-second data packet collections within the GLAS Level 0 Data Product files will be in ascending time order based on the packet group time tag. All parameters and elements contained within the packets are synchronous at either forty hertz, five hertz, two hertz, or one hertz. The GLAS Level 0 Data Product packet collection will contain GLAS instrument (altimeter and LIDAR), housekeeping, and position and attitude data (Star Cameras, laser pointing monitor, and GPS receiver) packets.

5.4 Recipients and Utilization

The EOS Data and Operations System is the initial recipient of the constituent raw data for the eventual Level 0 Data Product. EDOS will perform the software processing required to produce the GLAS Level 0 Data Product from the GLAS instrument and spacecraft data.

The initial access of the GLAS Level 0 data is performed by the GLAS Instrument Engineering Team. The GLAS Instrument Team will access the data from the EOS Operating Center through the Instrument Support Terminal for EOS ALT spacecraft and GLAS operational system performance evaluation. The next recipient of the GLAS Level 0 Data Product is the DAAC. DAAC and GLAS Operations Teams will access the EDOS delivered data for the purpose of GLAS product quality assurance. At the DAAC, delivered data will be accessed by the GLAS Operations Team via the SCFs.

The EOSDIS Operations Team will access the Level 0 Data Product required to generate the standard Level 1A and Level 1B Data Products within the designated DAAC science processing facility. The subsequent audience for the GLAS Level 0 Data Product is the scientific, governmental, and educational community sectors.

5.5 Access

While EOS is intended to be a globally available and utilized mission program, access to the data is still operated under a security and integrity program to protect the data

and data system resources from unauthorized or destructive use. EOS has identified three classes of users who will have access to the data through the DAAC; these are 1) SCF users, 2) other scientists, and 3) guest users. These users will be enrolled under EOSDIS and receive individual access and authorization details under the Communications and Systems Management Segment security role. Users who are authorized EOS access can then avail themselves of the EOS services to retrieve the GLAS Level 0 Data Product as well as to query the metadata (i.e., data description information) from the EOS Science data base management server.

Internal access of the raw instrument and spacecraft data is supported through the EOS Operating Center. This access is limited to the GLAS Instrument Team utilizing the Instrument Support Terminal as the designated access node.

Data Product Definitions

6.1 Data Product Structure

The GLAS Level 0 Instrument Data Product will be generated as an EDOS instrument data product file of consisting of instrument and spacecraft subsystem data packets. Specifically, this is the group of data packets collected in a one-second interval. It includes the GLAS science instrument data (altimeter and LIDAR), instrument engineering / housekeeping data (including the group time tag), and stellar reference system data. Within the one-second data packet group, data are aggregated or collected within GLAS data parameter (i.e., packet) groupings.

The GLAS Data Parameters as shown in Table 3-2 “GLAS Level 0 Standard Data Parameters” are further subdivided into the GLAS Data Elements identified in Table 3-3 “GLAS Level 0 Standard Data Elements”. The data elements consist of measured, sampled, or averaged data values collected at the forty, five, two, or one hertz rate, and one or more items or arrays collected at that frequency. The data rate times the number of items establishes the total number of data items for a particular GLAS Data Element recorded in each packet in the one-second data group. Based on the frequency of the sampling of the particular instrument or spacecraft data subsystem, packets will be collected at the rate of ten, four, or one per second in the collection group.

6.2 Labeling and Identification

Each of the GLAS Level 0 Data Product files is uniquely identified according to ESDIS standards and guidelines. The form of this file name is TBD.

The structure and contents of the standard product label file attached to each GLAS Level 0 Data Product are contained in Appendix B, GLAS Level 0 Data Product -- EDOS Standard Label -- Contents and Description. Within the standard product label, the following keyword/value fields uniquely identify the GLAS Level 0 Data Product.

- Instrument Name
- Product Creation Time
- Generating Algorithm Name
- Generating Algorithm Identification
- Initial Packet Data Collection Time
- Final Packet Data Collection Time

Discrete terminology has been applied to identify particular GLAS Data Parameters and GLAS Data Elements as to the origin of the value within the GLAS instrument. The 1064 nanometer (nm) prefix has been attached to those elements associated with

the instrument infrared (IR) spectrum wavelength. Alternately, this has been identified as the λ_1 wavelength and is occasionally referred to as the altimeter associated measurement. The 532 nm prefix has been attached to those GLAS data elements associated with the green spectrum. Alternately, this has been identified as the λ_2 wavelength and is occasionally referred to as the LIDAR associated measurement.

6.3 Data Product Substructure Descriptions

The EDOS standard label contains an aggregate of [TBD] records of string information (TBD bytes in length) describing the GLAS Level 0 Data Product. Appendix B provides the format of the standard label including the keyword/value field contents.

The GLAS Level 0 Data Product file is linked to the EDOS standard product label. Each product file consists of the one-second aggregate or collection of specific GLAS instrument and spacecraft packet types. Based on the sampling frequency of the packet originating subsystem, the packet collection will include packets at the rate of ten, four, and one per second. The one-second group includes the appropriate instrument and spacecraft measurement elements from the GLAS science instrument as the altimeter and LIDAR data packets, the GLAS engineering / housekeeping (including the GLAS instrument time tag element) as the housekeeping data packets, the GPS receiver data packets, the dual star camera data packets, and the external laser pointing monitor data packets. The specific packet type will contain the data elements as recorded, collected, averaged, or sampled at the forty hertz, five hertz, two hertz, or one hertz rate. The specific layout, format, and content of the GLAS Level 0 Data Product aggregates or records are provided in Appendix C, GLAS Level 0 Data Product - Format.

6.4 Detailed Data Descriptions

The detailed information describing the GLAS Level 0 Data Product comprising the data elements and the contents of the one-second data collection is provided as a data dictionary in Appendix D, GLAS Level 0 Data Product - Detailed Data Contents and Description.

Table 6-1 “GLAS Terms and Explanations” is provided as a road map for the detailed descriptions presented in Appendix D.

Table 6-1 GLAS Terms and Explanations

Data Detail Field	Explanation
Element Name	the GLAS Data Element name, describes the unique GLAS item, items, or array as a member of the GLAS Data Parameter collection
Product Identification	the EOS Data Product Identification label of the Data Product containing the GLAS Data Element and the GLAS Data Parameter, obtained from the EOS Senior Project Scientist List of Data Products

Table 6-1 GLAS Terms and Explanations

Data Detail Field	Explanation
Parameter Number	the unique GLAS Data Parameter identification number used to denote the collection or group of which the GLAS Data Element is a member
Description	a text description of the contents and discipline interest of the GLAS instrument or sensor data element
Minimum Value	the lowest representable value within the data element or the actual physical element minimum value based on the units configuration
Nominal Value	the routine expected value for the data element
Maximum Value	the largest representable value within the data element or the actual largest physical data element value based on the units configuration
Elements/Second	the number of times the GLAS Data Element is repeated in the record expressed as rate, per second (e.g., 5 for five elements per second)
Units	the output measurement units for the GLAS Data Element as it appears on the record in the data product (e.g., millimeters)
Items/Element	the number of data items (values) or arrays of values contained in the record for the GLAS Data Element (e.g., 2 for two items per element)
Precision	the required representation resolution of the least significant digit of the measurement for the GLAS Data Element value (e.g., 1 millisecond)
Bytes/Item	the size of each data item (value) contained in the GLAS Data Element, expressed in bytes

Appendix A

Level 0 Data Products

Instrument Packets and Contents

This appendix contains a table (Table A-1) depicting the composition of the GLAS LASER Altimeter and LIDAR data packets. The altimeter data are collected along with the ancillary data from the Stellar Reference System. Each blocked table portion indicates an overall packet source and the specific components or measurements supplying the contained quantities.

The contribution of each packet component is shown in the number of bits, words, and samples, and the per second rate within the packet. The packet size in bits and the packet frequency are necessary to assess the data burden of each packet component. The final fields indicate the anticipated packet component overhead allotted for packet header information.

Table A-1 EOS ALT Spacecraft and GLAS Instrument Subsystems' Data Rate

				KBPS	KBPS	KBPS	BPS	Bits	Samples	per/sec
1.0	System			1.67						
			Broadcast Time Code from GPS				32	32	1	1
			Broadcast UTC offset from GPS				64	32	2	1
			Broadcast Lat. & Lom. From GPS				32	32	1	1
			Laser shot GPS timing vernier (50 - 100us accuracy)				20	20	1	1
			Laser shot counter				320	8	1	40
			TBD - System status flags, registers, etc.				800	16	50	1
			Misc. housekeeping				400	16	25	1
3.0	Laser			2.56						
	3.1	Optics								
		3.1.1	1064 Transmit Energy				320	8	1	40
		3.1.2	532nm Transmit Energy				320	8	1	40
	3.2	Electronics								
		3.2.1	Pulse trigger timing				120	12	1	10
		3.2.2	Pump pulse width and amplitude				240	12	2	10
		3.2.3	Volts, current & temp's				1560	12	13	10
4.0	Stellar Reference System			209.60						
	4.1	Attitude Determination			23.17					

Table A-1 EOS ALT Spacecraft and GLAS Instrument Subsystems' Data Rate (Continued)

				KBPS	KBPS	KBPS	BPS	Bits	Samples	per/sec
		4.1.1	Star Camera (10Hz)				11648	16	182	4
		4.1.2	HRG Gyro (Litton)				11520	24	12	40
	4.2	Laser Reference Sensor			182.44					
		4.2.1	CCD Sector - Laser pointing image - 16 x 16				122880	12	256	40
				Laser sector address (x,y)			720	9	2	40
				Laser centroid (x,y,i)			1920	16	3	40
			CCD Sector - Star Camera pointing image - 10 x 10				1200	12	100	1
				Star Camera sector address (x,y)			18	9	2	1
				Star Camera centroid			1920	16	3	40
			CCD Sector - Gyro pointing image				1200	12	100	1
				Gyro sector address (x,y)			18	9	2	1
				Gyro centroid (x,y,i)			1920	16	3	40
			CCD Sector - Star image - 10 x 10				48000	12	100	40
				Star sector address (x,y)			720	9	2	40
				Star centroid (x,y,i)			1920	16	3	40
			Laser shot counter				320	8	1	40
			GPS time code + UTC offset + inst. timing vernier				96	32	3	1
	4.3	Spacecraft Position Data			4.00					
		4.3.1	GPS (50x8x10x0.1x4) - ~ 20MB/day + 2KBS commanding				4000	8	500	1

Table A-1 EOS ALT Spacecraft and GLAS Instrument Subsystems' Data Rate (Continued)

				KBPS	KBPS	KBPS	BPS	Bits	Samples	per/sec
6.0	Electronics			246.01						
	6.1	1064nm Altimeter			132.16					
			8-Bit A/D samples (400)				128000	8	400	40
			waveform averaging multiplier (X * 15cm/bin) 60m @ 15 cm ea. => X = 1 300m @ 75 cm ea. => X = 5				160	4	1	40
			Filter and tracking Parameters and Status				3200	8	10	40
			delta-TIU address data				800	20	1	40
			Programmable Gain Amplifier setting				8	8	1	1
			Detector status (A or B)				8	8	1	1
	6.2	1064nm Lidar - Cloud Top Height			57.18					
			20km to 10km (133 bins/8 shot avg. - 8 Bit counter)				5320	8	133	5
			10km to -1km - Boundary layer (146 bins - 8 Bit counter)				46720	8	146	40
			-5Km - (-4.25km) Background (16 bins - no avg'ng - 8 bit counter)				5120	8	16	40
			Range delay for start of 20km segment (max. update rate 4/5 sec.)				16	16	1	1
	6.3	532nm Lidar			56.19					
		6.3.1	Aerosols & Boundary Layer (35km to -5km)			56.01				
				40km to 20km Aerosols (267 bins/32 shot avg. - 10 Bit counter)			2670	8	267	1.25
				20km to 10km Aerosols (133 bins/8 shot avg. - 8 Bit counter)			5320	8	133	5

Table A-1 EOS ALT Spacecraft and GLAS Instrument Subsystems' Data Rate (Continued)

				KBPS	KBPS	KBPS	BPS	Bits	Samples	per/sec
				10km to -1km Aerosols (146 bins - no avg'ng - 8 Bit counter)			46720	8	146	40
				Background count integration (2 x 1ms) intervals			1280	16	2	40
				Range delay for start of 40km segment (max. update rate 4/5 sec.)			20	16	1	1.25
		6.3.2	Pointing Controller			0.13				
				Motor encoder position (2 axis)			32	16	2	1
				Feedback monitor value (Quad. Det.)			64	16	4	1
				Motor input control command			32	16	2	1
				Limit position status - x2			4	2	2	1
		6.3.3	Etalon Filter control			0.05				
				Temperature monitor			16	16	1	1
				Heater drive control point			16	16	1	1
				Feedback monitor value (PIN diode)			16	16	1	1
	6.4	Power Converters			0.48					
			Voltage monitors				160	8	20	1
			Current monitors				160	8	20	1
			Temperature monitors				160	8	20	1
7.0	Thermal			0.36						
			Temperature monitors				120	8	15	1

Table A-1 EOS ALT Spacecraft and GLAS Instrument Subsystems' Data Rate (Continued)

				KBPS	KBPS	KBPS	BPS	Bits	Samples	per/sec
			Temperature controller set points				120	8	15	1
			Temperature controller drive value				120	8	15	1
8.0	Mechanical			0.36						
			HOP mechanisms monitor status - 3x5				120	8	15	1
			HOP mechanism limit status - 3x5				120	8	15	1
			HOP mechanism drive value - 3x5				120	8	15	1
GLAS Sub-system totals:				460.56	KBPS					
GLAS Sub-system totals w/out GPS data:				456.56	KBPS					
System Reserve (15% - w/out GPS data)				68.48	KBPS					
Total:				525.04	KBPS					
Total with 40% compression - (x 0.6)				315.03	KBPS	RS-422 Science Data (Includes H&W data)				
Total with 50% compression - (x 0.5)				262.52	KBPS	RS-422 Science Data (Includes H&W data)				
Total with 60% compression - (x 0.4)				210.02	KBPS	RS-422 Science Data (Includes H&W data)				
Selected H&W Data:				0.000	KBPS	1553 Health & Welfare Data				

Appendix B
GLAS Level 0 Data Products
EDOS Standard Label - Contents and Description
To Be Provided

Appendix C
GLAS Level 0 Data Products
Format

To Be Provided

Appendix D **GLAS Level 0 Data Products** **Detailed Data Contents and Description**

<i>Element Name</i>	<i>Product Identification</i>	<i>Parameter Number</i>
<i>Description</i>		
<i>Minimum Value</i>	<i>Nominal Value</i>	<i>Maximum Value</i>
<i>Elements/Second</i>	<i>Units</i>	
<i>Items/Element</i>	<i>Precision</i>	
<i>Bytes/Item</i>		

Table D-1 GLAS Level 0 Data Products -- Detailed Contents and Description

1064 nm Background Data from -5 KM to -4.25 KM	GLA00	GLL02
The -5 KM to -4.25 KM range in the atmosphere (background) is divided into 16 bins. The 1064 nm data is given for each bin at the 40 hertz rate (no data averaging).		
Min/Nom/Max Value:	0.00	0.00 0.00
Element/Second: 40	Units:	Counts
Items/Element: 16	Precision:	
Bytes/Item: 1.00		
1064 nm Background Signal	GLA00	GLL01
The background signal at the end of each 1064 nm aerosol data segment (30 samples per segment).		
Min/Nom/Max Value:	0.00	0.00 0.00
Element/Second: 40	Units:	Counts
Items/Element: 1	Precision:	
Bytes/Item: 1.00		
1064 nm Laser Transmit Energy	GLA00	GLL01
The 1064 nm laser transmit energy in raw counts.		
Min/Nom/Max Value:	0.00	0.00 0.00
Element/Second: 40	Units:	Counts
Items/Element: 1	Precision:	
Bytes/Item: 1.00		
1064 nm Lidar Data from 10 KM to -1 KM	GLA00	GLL02

Table D-1 GLAS Level 0 Data Products -- Detailed Contents and Description

The 10 KM to -1 KM range in the atmosphere (the boundary layer) is divided into 146 bins. The 1064 nm data is given for each bin at the 40 hertz rate.

Min/Nom/Max Value:	0.00	0.00	0.00
Element/Second:	40	Units:	Counts
Items/Element:	146	Precision:	
Bytes/Item:	1.00		

1064 nm Lidar Data from 20 KM to 10 KM GLA00 GLL02

The 20 KM to 10 KM range in the atmosphere is divided into 133 bins. The 1064 nm data is given for each bin as an average of 8 shots.

Min/Nom/Max Value:	0.00	0.00	0.00
Element/Second:	5	Units:	Counts
Items/Element:	133	Precision:	
Bytes/Item:	1.00		

532 nm Background Count Integration Intervals GLA00 GLL02

2 x 1ms intervals.

Min/Nom/Max Value:	0.00	0.00	0.00
Element/Second:	40	Units:	Counts
Items/Element:	2	Precision:	
Bytes/Item:	2.00		

532 nm Laser Transmit Energy GLA00 GLL02

The 532 nm laser transmit energy in raw counts.

Min/Nom/Max Value:	0.00	0.00	0.00
Element/Second:	4	Units:	Counts
Items/Element:	1	Precision:	
Bytes/Item:	1.00		

532 nm Laser Transmit Energy Threshold GLA00 GLL02

The threshold setting for the 532 nm laser transmit energy.

Min/Nom/Max Value:	0.00	0.00	0.00
Element/Second:	5	Units:	Counts
Items/Element:	1	Precision:	
Bytes/Item:	1.00		

532 nm Lidar Data from 10 KM to -1 KM GLA00 GLL02

Table D-1 GLAS Level 0 Data Products -- Detailed Contents and Description

The 10 KM to -1 KM range in the atmosphere is divided into 146 bins. The 532 nm aerosol data is given for each bin with no averaging.

Min/Nom/Max Value:	0.00	0.00	0.00
Element/Second:	40	Units:	Counts
Items/Element:	146	Precision:	
Bytes/Item:	1.00		

532 nm Lidar Data from 20 KM to 10 KM

GLA00

GLL02

The 20 KM to 10 KM range in the atmosphere is divided into 133 bins. The 532 nm aerosol data is given for each bin as an average of 8 shots.

Min/Nom/Max Value:	0.00	0.00	0.00
Element/Second:	5	Units:	Counts
Items/Element:	133	Precision:	
Bytes/Item:	1.00		

532 nm Lidar Data from 40 KM to 20 KM

GLA00

GLL02

The 40 KM to 20 KM range in the atmosphere is divided into 267 bins. The 532 nm aerosol data is given for each bin as an average of 40 shots.

Min/Nom/Max Value:	0.00	0.00	0.00
Element/Second:	1	Units:	Counts
Items/Element:	267	Precision:	
Bytes/Item:	1.00		

A/D Samples

GLA00

GLL01

400 8 bit A/D samples.

Min/Nom/Max Value:	0.00	0.00	0.00
Element/Second:	40	Units:	Counts
Items/Element:	400	Precision:	
Bytes/Item:	1.00		

Altimetry Packet Header

GLA00

GLL01

Telemetry header, CRC, and spares. Details of contents TBD.

Min/Nom/Max Value:	0.00	0.00	0.00
Element/Second:	1	Units:	
Items/Element:	8	Precision:	
Bytes/Item:	1.00		

Table D-1 GLAS Level 0 Data Products -- Detailed Contents and Description

CCD Sector Gyro Pointing Image		GLA00	GLL04
10 X 10 Image.			
Min/Nom/Max Value:	0.00	0.00	0.00
Element/Second:	1	Units:	
Items/Element:	100	Precision:	
Bytes/Item:	1.50		
CCD Sector Laser Pointing Image		GLA00	GLL04
16x16 image.			
Min/Nom/Max Value:	0.00	0.00	0.00
Element/Second:	40	Units:	
Items/Element:	256	Precision:	
Bytes/Item:	1.50		
CCD Sector Star Camera Pointing Image		GLA00	GLL04
10x10 image.			
Min/Nom/Max Value:	0.00	0.00	0.00
Element/Second:	1	Units:	
Items/Element:	100	Precision:	
Bytes/Item:	1.50		
CCD Sector Star Image		GLA00	GLL04
10x10 image.			
Min/Nom/Max Value:	0.00	0.00	0.00
Element/Second:	40	Units:	
Items/Element:	100	Precision:	
Bytes/Item:	1.50		
Delta-TIU Address Data		GLA00	GLL01
Min/Nom/Max Value:	0.00	0.00	0.00
Element/Second:	40	Units:	Counts
Items/Element:	1	Precision:	
Bytes/Item:	2.50		
Detector Status (A or B)		GLA00	GLL01

Table D-1 GLAS Level 0 Data Products -- Detailed Contents and Description

Min/Nom/Max Value:	0.00	0.00	0.00
Element/Second:	1	Units:	
Items/Element:	1	Precision:	
Bytes/Item:	1.00		
Electronic Monitors		GLA00	GLL07
Electronic voltage, current, and temperature monitors output.			
Min/Nom/Max Value:	0.00	0.00	0.00
Element/Second:	10	Units:	
Items/Element:	13	Precision:	
Bytes/Item:	1.50		
Electronic Pulse Trigger Timing		GLA00	GLL07
Min/Nom/Max Value:	0.00	0.00	0.00
Element/Second:	10	Units:	
Items/Element:	1	Precision:	
Bytes/Item:	1.50		
Electronic Pump		GLA00	GLL07
Electronic pump pulse width and amplitude			
Min/Nom/Max Value:	0.00	0.00	0.00
Element/Second:	10	Units:	
Items/Element:	2	Precision:	
Bytes/Item:	1.50		
Etalon Filter Feedback Monitor		GLA00	GLL07
Min/Nom/Max Value:	0.00	0.00	0.00
Element/Second:	1	Units:	
Items/Element:	1	Precision:	
Bytes/Item:	2.00		
Etalon Filter Heater Drive Control Point		GLA00	GLL07

Table D-1 GLAS Level 0 Data Products -- Detailed Contents and Description

Min/Nom/Max Value:	0.00	0.00	0.00
Element/Second:	1	Units:	
Items/Element:	1	Precision:	
Bytes/Item:	2.00		
Etalon Filter Temperature		GLA00	GLL07
Min/Nom/Max Value:	0.00	0.00	0.00
Element/Second:	1	Units:	
Items/Element:	1	Precision:	
Bytes/Item:	2.00		
Feedback Monitor Value (Quad Det)		GLA00	GLL07
Pointing controller data			
Min/Nom/Max Value:	0.00	0.00	0.00
Element/Second:	1	Units:	
Items/Element:	4	Precision:	
Bytes/Item:	2.00		
Filter and Tracking Parameters and Status		GLA00	GLL01
Filter and Tracking Parameters and Status.			
Min/Nom/Max Value:	0.00	0.00	0.00
Element/Second:	40	Units:	
Items/Element:	10	Precision:	
Bytes/Item:	1.00		
Flags		GLA00	GLL02
Flags; details TBD.			
Min/Nom/Max Value:	0.00	0.00	0.00
Element/Second:	5	Units:	Counts
Items/Element:	1	Precision:	
Bytes/Item:	1.00		
GPS Broadcast Lat and Lon		GLA00	GLL07
Min/Nom/Max Value:	0.00	0.00	0.00

Table D-1 GLAS Level 0 Data Products -- Detailed Contents and Description

Element/Second:	1	Units:		
Items/Element:	2	Precision:		
Bytes/Item:	4.00			
GPS Broadcast UTC Offset			GLA00	GLL07
Min/Nom/Max Value:		0.00	0.00	0.00
Element/Second:	1	Units:		
Items/Element:	1	Precision:		
Bytes/Item:	4.00			
GPS Broadcast UTC Offset			GLA00	GLL04
Min/Nom/Max Value:		0.00	0.00	0.00
Element/Second:	1	Units:		
Items/Element:	1	Precision:		
Bytes/Item:	4.00			
GPS Data			GLA00	GLL05
GPS data in a (50x8x10x0.1x4) array for approximately 20 MB per day + 2KBS commanding; GPS data for 12 channels?				
Min/Nom/Max Value:		0.00	0.00	0.00
Element/Second:	1	Units:		
Items/Element:	500	Precision:		
Bytes/Item:	1.00			
GPS Data Header			GLA00	GLL05
Telemetry header, CRC, and spares. Details of contents TBD.				
Min/Nom/Max Value:		0.00	0.00	0.00
Element/Second:	1	Units:		
Items/Element:	8	Precision:		
Bytes/Item:	1.00			
GPS Ephemeris and Velocity Message			GLA00	GLL05
The GPS ephemeris and velocity message. Occurs at a rate of once per 10 seconds. More details TBD.				
Min/Nom/Max Value:		0.00	0.00	0.00

Table D-1 GLAS Level 0 Data Products -- Detailed Contents and Description

Element/Second:	0	Units:		
Items/Element:	7	Precision:		
Bytes/Item:	4.00			
Gyro Centroid		GLA00		GLL04
The (x,y,i) describing the CCD Sector Gyro Pointing Image Centroid.				
Min/Nom/Max Value:	0.00	0.00		0.00
Element/Second:	40	Units:		
Items/Element:	3	Precision:		
Bytes/Item:	2.00			
Gyro Sector Address		GLA00		GLL04
The address (x,y) for each Gyro Pointing Image in the CCD Sector.				
Min/Nom/Max Value:	0.00	0.00		0.00
Element/Second:	1	Units:		
Items/Element:	2	Precision:		
Bytes/Item:	1.13			
HOP Mechanism Drive Value		GLA00		GLL07
Drive value of 3 HOP mechanism pairs (3 X 5).				
Min/Nom/Max Value:	0.00	0.00		0.00
Element/Second:	1	Units:		
Items/Element:	15	Precision:		
Bytes/Item:	1.00			
HOP Mechanism Limit		GLA00		GLL07
Limit status of 3 HOP mechanism pairs (3 X 5).				
Min/Nom/Max Value:	0.00	0.00		0.00
Element/Second:	1	Units:		
Items/Element:	15	Precision:		
Bytes/Item:	1.00			
HOP Mechanisms Monitor		GLA00		GLL07
Monitor status of 3 HOP mechanism pairs (3 X 5).				
Min/Nom/Max Value:	0.00	0.00		0.00
Element/Second:	1	Units:		

Table D-1 GLAS Level 0 Data Products -- Detailed Contents and Description

HRG Gyro (Litton)	Items/Element:	15	Precision:		
	Bytes/Item:	1.00			
				GLA00	GLL06
	Min/Nom/Max Value:		0.00	0.00	0.00
	Element/Second:	40	Units:		
	Items/Element:	12	Precision:		
	Bytes/Item:	3.00			
Header				GLA00	GLL06
The telemetry header, CRC, and spares. Details TBD.					
	Min/Nom/Max Value:		0.00	0.00	0.00
	Element/Second:	1	Units:		
	Items/Element:	8	Precision:		
	Bytes/Item:	1.00			
Housekeeping Data Header				GLA00	GLL07
Telemetry header, CRC, and spares. Details of contents TBD.					
	Min/Nom/Max Value:		0.00	0.00	0.00
	Element/Second:	1	Units:		
	Items/Element:	8	Precision:		
	Bytes/Item:	1.00			
LIDAR Threshold D/A Setting				GLA00	GLL02
The threshold D/A setting with a 1 Hz update rate.					
	Min/Nom/Max Value:		0.00	0.00	0.00
	Element/Second:	2	Units:		Counts
	Items/Element:	1	Precision:		
	Bytes/Item:	1.00			
LRS Data Header				GLA00	GLL04
Telemetry header, CRC, and spares for Laser Reference System packet. Details of contents TBD.					
	Min/Nom/Max Value:		0.00	0.00	0.00
	Element/Second:	1	Units:		
	Items/Element:	8	Precision:		

Table D-1 GLAS Level 0 Data Products -- Detailed Contents and Description

Bytes/Item:	1.00		
Laser A,B,C Select Status		GLA00	GLL07
Min/Nom/Max Value:	0.00	0.00	0.00
Element/Second:	1	Units:	
Items/Element:	3	Precision:	
Bytes/Item:	1.00		
Laser Centroid		GLA00	GLL04
The (x,y,i) describing the CCD Sector Laser Pointing Image Centroid.			
Min/Nom/Max Value:	0.00	0.00	0.00
Element/Second:	40	Units:	
Items/Element:	3	Precision:	
Bytes/Item:	2.00		
Laser Sector Address		GLA00	GLL04
The address (x,y) for each Laser Pointing Image in the CCD Sector.			
Min/Nom/Max Value:	0.00	0.00	0.00
Element/Second:	40	Units:	
Items/Element:	2	Precision:	
Bytes/Item:	1.13		
Laser Shot Counter		GLA00	GLL07
Min/Nom/Max Value:	0.00	0.00	0.00
Element/Second:	40	Units:	
Items/Element:	1	Precision:	
Bytes/Item:	1.00		
Laser Shot Counter		GLA00	GLL04
Min/Nom/Max Value:	0.00	0.00	0.00
Element/Second:	40	Units:	
Items/Element:	1	Precision:	
Bytes/Item:	1.00		

Table D-1 GLAS Level 0 Data Products -- Detailed Contents and Description

Laser Shot GPS Timing Vernier		GLA00	GLL01
The laser shot GPS timing vernier at 1 microsecond accuracy.			
Min/Nom/Max Value:	0.00	0.00	0.00
Element/Second:	1	Units:	Counts
Items/Element:	1	Precision:	
Bytes/Item:	2.50		
Laser Shot GPS Timing Vernier		GLA00	GLL04
Min/Nom/Max Value:	0.00	0.00	0.00
Element/Second:	1	Units:	
Items/Element:	1	Precision:	
Bytes/Item:	4.00		
Lidar Packet Header		GLA00	GLL02
The telemetry header, CRC, and spares. Details TBD.			
Min/Nom/Max Value:	0.00	0.00	0.00
Element/Second:	1	Units:	Counts
Items/Element:	8	Precision:	
Bytes/Item:	1.00		
Limit Position status		GLA00	GLL07
Pointing controller data			
Min/Nom/Max Value:	0.00	0.00	0.00
Element/Second:	1	Units:	
Items/Element:	2	Precision:	
Bytes/Item:	0.25		
Miscellaneous Housekeeping		GLA00	GLL07
This element encompasses miscellaneous housekeeping data which can include temperature, current, and voltage monitor outputs in raw counts, instrument status, and time. Details are TBD with final version likely to contain separate elements for each.			
Min/Nom/Max Value:	0.00	0.00	0.00
Element/Second:	1	Units:	
Items/Element:	25	Precision:	
Bytes/Item:	2.00		

Table D-1 GLAS Level 0 Data Products -- Detailed Contents and Description

Motor Encoder Position (2 axis)			GLA00	GLL07
Pointing controller data				
Min/Nom/Max Value:		0.00	0.00	0.00
Element/Second:	1		Units:	
Items/Element:	2		Precision:	
Bytes/Item:	2.00			
Motor Input Control Command			GLA00	GLL07
Min/Nom/Max Value:		0.00	0.00	0.00
Element/Second:	1		Units:	
Items/Element:	2		Precision:	
Bytes/Item:	2.00			
Power Converter Voltage			GLA00	GLL07
Power converters voltage monitors output				
Min/Nom/Max Value:		0.00	0.00	0.00
Element/Second:	1		Units:	
Items/Element:	20		Precision:	
Bytes/Item:	1.00			
Power Converters Current			GLA00	GLL07
Power converters current monitors output				
Min/Nom/Max Value:		0.00	0.00	0.00
Element/Second:	1		Units:	
Items/Element:	20		Precision:	
Bytes/Item:	1.00			
Power Converters Temperatures			GLA00	GLL07
Power converters temperature monitors output				
Min/Nom/Max Value:		0.00	0.00	0.00
Element/Second:	1		Units:	
Items/Element:	20		Precision:	
Bytes/Item:	1.00			
Programmable Gain Amplifier Setting			GLA00	GLL01

Table D-1 GLAS Level 0 Data Products -- Detailed Contents and Description

Min/Nom/Max Value:	0.00	0.00	0.00
Element/Second:	1	Units:	
Items/Element:	1	Precision:	
Bytes/Item:	1.00		
Range Delay for Start of 1064 nm Lidar Data 20 KM Segment		GLA00	GLL02
Range delay value for the start of the 20 KM to 10KM layer; the maximum update rate is 4/5 of a second.			
Min/Nom/Max Value:	0.00	0.00	0.00
Element/Second:	1	Units:	Counts
Items/Element:	1	Precision:	
Bytes/Item:	2.00		
Range Delay for Start of 532 nm Lidar Data 40 KM Segment		GLA00	GLL02
Range delay value for the start of the 40 KM to 20KM layer; the maximum update rate is 4/5 of a second.			
Min/Nom/Max Value:	0.00	0.00	0.00
Element/Second:	5	Units:	Counts
Items/Element:	1	Precision:	
Bytes/Item:	2.00		
Spacecraft Time Code		GLA00	GLL01
The broadcast time code from the spacecraft (GPS).			
Min/Nom/Max Value:	0.00	0.00	0.00
Element/Second:	1	Units:	
Items/Element:	1	Precision:	
Bytes/Item:	4.00		
Spacecraft Time Code		GLA00	GLL02
The broadcast time code from the spacecraft (GPS).			
Min/Nom/Max Value:	0.00	0.00	0.00
Element/Second:	1	Units:	Counts
Items/Element:	1	Precision:	
Bytes/Item:	4.00		
Spacecraft Time Code		GLA00	GLL03

Table D-1 GLAS Level 0 Data Products -- Detailed Contents and Description

The broadcast time code from the spacecraft (GPS).			
Min/Nom/Max Value:	0.00	0.00	0.00
Element/Second:	1	Units:	
Items/Element:	1	Precision:	
Bytes/Item:	4.00		
Spacecraft Time Code		GLA00	GLL04
The broadcast time code from the spacecraft (GPS).			
Min/Nom/Max Value:	0.00	0.00	0.00
Element/Second:	1	Units:	
Items/Element:	1	Precision:	
Bytes/Item:	4.00		
Spacecraft Time Code		GLA00	GLL05
The broadcast time code from the spacecraft (GPS).			
Min/Nom/Max Value:	0.00	0.00	0.00
Element/Second:	1	Units:	
Items/Element:	1	Precision:	
Bytes/Item:	4.00		
Spacecraft Time Code		GLA00	GLL07
The broadcast time code from the spacecraft (GPS).			
Min/Nom/Max Value:	0.00	0.00	0.00
Element/Second:	1	Units:	
Items/Element:	1	Precision:	
Bytes/Item:	4.00		
Spacecraft Time Code		GLA00	GLL06
The broadcast time code from the spacecraft (GPS).			
Min/Nom/Max Value:	0.00	0.00	0.00
Element/Second:	1	Units:	
Items/Element:	1	Precision:	
Bytes/Item:	4.00		
Star Camera		GLA00	GLL03
The star camera centroid position data; produced at 10 Hz rate.			

Table D-1 GLAS Level 0 Data Products -- Detailed Contents and Description

Min/Nom/Max Value:	0.00	0.00	0.00
Element/Second:	4	Units:	
Items/Element:	182	Precision:	
Bytes/Item:	2.00		
Star Camera Centroid		GLA00	GLL04
The (x,y,i) describing the CCD Sector Star Camera Pointing Image Centroid.			
Min/Nom/Max Value:	0.00	0.00	0.00
Element/Second:	40	Units:	
Items/Element:	3	Precision:	
Bytes/Item:	2.00		
Star Camera Data Header		GLA00	GLL03
Telemetry header, CRC, and spares. Details of contents TBD.			
Min/Nom/Max Value:	0.00	0.00	0.00
Element/Second:	1	Units:	
Items/Element:	8	Precision:	
Bytes/Item:	1.00		
Star Camera Sector Address		GLA00	GLL04
The address (x,y) for each Star Camer Pointing Image in the CCD Sector.			
Min/Nom/Max Value:	0.00	0.00	0.00
Element/Second:	1	Units:	
Items/Element:	2	Precision:	
Bytes/Item:	1.13		
Star Centroid		GLA00	GLL04
The (x,y,i) describing the CCD Sector Star Pointing Image Centroid.			
Min/Nom/Max Value:	0.00	0.00	0.00
Element/Second:	40	Units:	
Items/Element:	3	Precision:	
Bytes/Item:	2.00		
Star Sector Address		GLA00	GLL04
The address (x,y) for each Star Pointing Image in the CCD Sector.			
Min/Nom/Max Value:	0.00	0.00	0.00

Table D-1 GLAS Level 0 Data Products -- Detailed Contents and Description

Element/Second:	40	Units:		
Items/Element:	2	Precision:		
Bytes/Item:	1.13			
System Status			GLA00	GLL07
TBD - system status flags, registers, etc.				
Min/Nom/Max Value:		0.00	0.00	0.00
Element/Second:	1	Units:		
Items/Element:	50	Precision:		
Bytes/Item:	2.00			
Temperature Controller Drive Value			GLA00	GLL07
For thermal.				
Min/Nom/Max Value:		0.00	0.00	0.00
Element/Second:	1	Units:		
Items/Element:	15	Precision:		
Bytes/Item:	1.00			
Temperature Controller Set Points			GLA00	GLL07
For thermal.				
Min/Nom/Max Value:		0.00	0.00	0.00
Element/Second:	1	Units:		
Items/Element:	15	Precision:		
Bytes/Item:	1.00			
Thermal Temperatures			GLA00	GLL07
Temperature monitor outputs for thermal.				
Min/Nom/Max Value:		0.00	0.00	0.00
Element/Second:	1	Units:		
Items/Element:	15	Precision:		
Bytes/Item:	1.00			
Waveform Averaging Multiplier			GLA00	GLL01
Waveform averaging multiplier where $X * 15\text{cm/bin}$. For 60 meters @ 15 cm each then $X = 1$. For 300 meters @ 75 cm each then $X = 5$.				
Min/Nom/Max Value:		0.00	0.00	0.00
Element/Second:	40	Units:		Counts

Table D-1 GLAS Level 0 Data Products -- Detailed Contents and Description

Items/Element:	1	Precision:
Bytes/Item:	0.50	

Abbreviations & Acronyms

ALT	EOS-Altimeter spacecraft series
COTS	commercial-off-the-shelf software packages
DAAC	Distributed Active Archive Center
ECS	EOSDIS Core System
EDOS	EOS Data and Operations System
EOC	EOS Operating Center
EOS	Earth Observing System
EOSDIS	Earth Observing System Data and Information System
ESDIS	Earth Science Data and Information System
GLAS	Geoscience Laser Altimeter System
GPS	Global Positioning System
GSFC	NASA Goddard Space Flight Center at Greenbelt, Maryland
GSFC/WFF	NASA Goddard Space Flight Center/Wallops Flight Facility at Wallops Island, Virginia
Hz	Hertz
ID	Identification
IEEE	Institute for Electronics and Electrical Engineering
IST	GLAS Instrument Support Terminal
L0	Level 0
LASER	Light Amplification by Stimulated Emission of Radiation
LIDAR	Light Detection and Ranging
μm	micrometers
NASA	National Aeronautics and Space Administration
nm	nanometer
QA	Quality Assurance
SCF	GLAS investigation Science Computing Facility and workstation(s)
SDP	Science Data Production Toolkit
TBD	to be determined, to be done, or to be developed
TCP/IP	Transmission Control Protocol/Internet Protocol network access standard/protocol

UNIX	the UNIX operating system jointly developed by the AT&T Bell Laboratories and the University of California-Berkeley System Division
UTC	Coordinated Universal Time

Glossary

aggregate	A collection, assemblage, or grouping of distinct data parts together to make a whole. It is generally used to indicate the grouping of GLAS data items, arrays, elements, and EOS parameters into a data record. For example, the collection of Level 1B EOS Data Parameters gathered to form a one-second Level 1B data record. It could be used to represent groupings of various GLAS data entities such as data items aggregated as an array, data items and arrays aggregated into a GLAS Data Element, GLAS Data Elements aggregated as an EOS Data Parameter, or EOS Data Parameters aggregated into a Data Product record.
array	An ordered arrangement of homogenous data items that may either be synchronous or asynchronous. An array of data items usually implies the ability to access individual data items or members of the array by an index. An array of GLAS data items might represent the three coordinates of a georeference location, a collection of values at a rate, or a collection of values describing an altimeter waveform.
element	Specifically, a GLAS Data Element. A GLAS Data Element is identified by a unique element number, and is composed of a data item or an array of items. A GLAS Data Element represents the decomposable unit of data contained in an EOS Data Parameter.
file	A collection of data stored as records and terminated by a physical or logical end-of-file (EOF) marker. The term usually applies to the collection within a storage device or storage media such as a disk file or a tape file. Loosely employed it is used to indicate a collection of GLAS data records without a standard label. For the Level 1A Data Product, the file would constitute the collection of one-second Level 1A data records generated in the DAAC working storage for a single pass.
header	A text and/or binary label or information record, record set, or block, prefacing a data record, record set, or a file. A header usually contains identifying or descriptive information, and may sometimes be embedded within a record rather than attached as a prefix.
item	Specifically, a data item. A discrete, non-decomposable unit of data, usually a single word or value in a data record, or a single value from a data array. The representation of a single GLAS data value within a data array or a GLAS Data Element.
label	The text and/or binary information records, record set, block, header, or headers prefacing a data file or linked to a data file sufficient to form a labeled data product. A standard label may imply a standard data product. A label may consist of a single header as well as multiple headers and markers depending on the defining authority.
Level 0	The level designation applied to an EOS data product that consists of raw instrument data, recorded at the original resolution, in time order, with any duplicate or redundant data packets removed.

Level 1A	The level designation applied to an EOS data product that consists of reconstructed, unprocessed Level 0 instrument data, recorded at the full resolution with time referenced data records, in time order. The data are annotated with ancillary information including radiometric and geometric calibration coefficients, and georeferencing parameter data (i.e., ephemeris data). The included, computed coefficients and parameter data have not however been applied to correct the Level 0 instrument data contents.
Level 1B	The level designation applied to an EOS data product that consists of Level 1A data that have been radiometrically corrected, processed from raw data into sensor data units, and have been geolocated according to applied georeferencing data.
Level 2	The level designation applied to an EOS data product that consists of derived geophysical data values, recorded at the same resolution, time order, and georeference location as the Level 1A or Level 1B data.
Level 3	The level designation applied to an EOS data product that consists of geophysical data values derived from Level 1 or Level 2 data, recorded at a temporally or spatially resampled resolution.
Level 4	The level designation applied to an EOS data product that consists of data from modeled output or resultant analysis of lower level data that are not directly derived by the GLAS instrument and supplemental sensors.
metadata	The textual information supplied as supplemental, descriptive information to a data product. It may consist of fixed or variable length records of ASCII data describing files, records, parameters, elements, items, formats, etc., that may serve as catalog, data base, keyword/value, header, or label data. This data may be parsable and searchable by some tool or utility program.
orbit revolution	The passage of time and spacecraft travel signifying a complete journey around a celestial or terrestrial body. For GLAS and the EOS LASER ALT spacecraft each orbit revolution count starts at the time when the spacecraft is on the equator traveling toward the North Pole, continues through the equator crossing as the spacecraft ground track moves toward the South Pole, and terminates when the spacecraft has reached the equator moving northward from the South Polar region.
packet	A data packet, referring to the basic aggregation of data values, usually raw data, as grouped in an instrument or flight computer, telemetry stream, or ground receiver system.
parameter	Specifically, an EOS Data Parameter. This is a defining, controlling, or constraining data unit associated with a EOS science community approved algorithm. It is identified by an EOS Parameter Number and Parameter Name. An EOS Data Parameter within the GLAS Data Product is composed of one or more GLAS Data Elements.

pass	A sub-segment of an orbit, it may consist of the ascending or descending portion of an orbit (e.g., a descending pass would consist of the ground track segment beginning with the northernmost point of travel through the following southernmost point of travel), or the segment above or below the equator (e.g., either the northern or southern hemisphere portion of the ground track on any orbit).
product	Specifically, the Data Product or the EOS Data Product. This is implicitly the labeled data product or the data product as produced by software on the DAAC or SCF. A GLAS data product refers to the data file or record collection either prefaced with a product label or standard formatted data label or linked to a product label or standard formatted data label file. Loosely used, it may indicate a single pass file aggregation, or the entire set of product files contained in a data repository.
record	A specific organization or aggregate of data items. It represents the collection of EOS Data Parameters within a given time interval, such as a one-second data record. It is the first level decomposition of a product file.
repeat cycle	The elapsed time span or number of orbits until a later orbit ground track superimposes on (or repeats) an earlier orbit's ground track.
Standard Data Product	Specifically, a GLAS Standard Data Product. It represents an EOS LASER ALT/GLAS Data Product produced on the DAAC for GLAS data product generation or within the GLAS Science Computing Facility using EOS science community approved algorithms. It is routinely produced and is intended to be archived in the EOSDIS data repository for EOS user community-wide access and retrieval.
variable	Usually a reference in a computer program to a storage location.

